FLOWABLE-MATERIAL TRANSFER DEVICE AND SYSTEM

BACKGROUND INFORMATION

FIELD OF THE INVENTION

[0001] The invention relates to the field of material handling systems. More particularly, the invention relates to a transfer system for safely moving flowable materials from one containment to another one. More particularly yet, the invention relates to a device for connecting and locking flowable-material transfer apparatus to a flowable-material container.

DESCRIPTION OF THE PRIOR ART

[0002] Transferring flowable material from one container to another is a common task in industry and commerce. The term "flowable materials" as used herein includes industrial solvents and petroleum products, foodstuffs, toxic and non-toxic materials, combustible and non-combustible materials. The term "flowable" includes liquids, gases, slurries, sludges, pastes, flowable solids, such as powdered, pulverized, granulated, pelletized, and encapsulated material, and other material that may flow naturally or be made to flow from one place of containment to another. The methods of transfer vary with the reasons for removal, the nature of the material, and the use to which the material is to be put. Whatever the reason for transferring a material from one container to another, the act of transfer always represents a heightened risk to the secure containment of the material. The risk is particularly great when the material is toxic, corrosive, or otherwise hazardous to the environment, or when working under large volumes of pressurized material. Increased awareness of environmental hazards and increased sensitivity to workers' safety have led to greater focus on ensuring the safety and reliability of material handling systems. Consequently, apparatuses and devices that help prevent or reduce the risk of spillage or leakage of flowable material

are extremely desirable and useful, both for reasons of general health and welfare and for economic reasons.

[0003] Many devices and systems have been developed to address the problem of unintentional escape of flowable material, be it by spillage or gaseous escape, during the transfer of flowable materials from one containment vessel to another. Most of these involve attaching external apparatus to the source containment vessel or system that enables the flowable material to be moved to a destination containment vessel or system through a completely enclosed conduit system that may comprise hose, tubing, pipe, ductwork,or other conduit, or may simply be the opening between two adjacent, "docked" systems. Two major sources of failure of a material transfer system are inherently present when transferring flowable materials: 1) the very act of connecting or disconnecting the external apparatus to the source container; and 2) failure of the connector device. For this reason, connector devices and valves are critical components of flowable-material transfer systems.

[0004] **U.S. Patent No. 5,765,612**, issued to the inventor of the present invention, discloses apparatus for safely draining motor oil from the oil pan of an engine crank case. The apparatus includes a three-part connector device. One part is semi-permanently assembled in the oil pan drain opening, replacing the standard solid drain plug. This oil-pan connector also includes a flow valve. The other part connects with the drain apparatus. When the two parts are connected together, they provide a flowpath for the oil to be drained from the oil pan, when the flow valve is open. Oil-pan drain openings on different vehicles may differ in size or type, and thus, the third part of the connector device is an adapter that enables connectors of various sizes and shapes to be connected to a standard size drain connector. The adapter is screwed onto the connector part that is fitted in the drain pan opening and mates easily and conveniently with the standardized connector that connects to the drain apparatus.

[0005] The disclosed connector device has several disadvantages. The fact that no means are provided to prevent one from detaching the connector of the drain apparatus from the oil pan connects the while the flow valve is open is a serious safety risk. Another disadvantage is that the service operator must first check for the size and type of adapter needed to fit the particular oil-pan source connector, and fetch and mount the adapter on the source connector before attaching the drain apparatus. This is time-consuming and, thus, cost-inefficient. A further disadvantage of the disclosed connector device is that an addtional pressure-actuated valve is incorporated into the part of the connector that connects to the drain apparatus. The drain apparatus includes a negative pressure system that assists the evacuation of the oil from the oil pan and the valve is used to apply the negative pressure to the flowpath. Incorporating this valve into the connector device itself, however, increases greatly the manufacturing cost of the connector device and also introduces an additional source of failure at this critical point. This pressure-actuated valve can be placed at any number of other places in the drain apparatus, where it is easier and simpler to install and maintain.

[0006] Conventional source-container connectors, *i.e.*, connectors attached to the container to be drained, typically include multiple components and are constructed to be disassemblable, either to permit adaptation of the source-container connector to a number of different connectors and/or to permit replacement of the components. The source-container connector fulfills a critical function with regard to safety and efficiency in the material transfer process and providing a connector that is disassemblable introduces a source of failure, and, thus, is undesirable. Furthermore, a disassemblable connector is generally more costly to manufacture, as the design of the device is more complex.

[0007] Most connectors for industrial applications include some provision to prevent the flow valve on the source-container from being accidentally or unintentionally opened. No provision is made, however, to prevent accidental or unintentional closure

of the valve. Closing a valve during processing of flowable material, particularly when pressure forces are involved to generate or assist flow, may cause degradation or failure of the source and/or destination containers and conduit on either side of the valve.

[0008] What is needed, therefore, is a system and device for safely and reliably transferring a flowable material from one container to another. What is further needed is such a device that is simple and quick to operate and is economic in its fabrication. What is yet further needed is such a device that effectively prevents an unintentional disconnection of the device while the flow valve is open. What is still further needed is such a device that reduces the risk of unintentional opening of the flow valve when the system is not connected, and unintentional closing of the valve during material transfer.

BRIEF SUMMARY OF THE INVENTION

[0009] For the reasons cited above, it is an object of the present invention to provide a flowable-material transfer system that includes a two-part connector device for transferring flowable material from a source container to a destination container. It is a further object of the present invention to provide a simple, inexpensive connector device within such a system that is easy to operate and effects a secure, safe, positive connection. It is a yet further object of the present invention to provide such a connection device that prevents an unintentional disconnection of the connector device when the flow valve is open. It is a still further object to provide such a device that reduces the risk of unintentional change in the operative state of the flow valve while material is being transferred, either from a closed to an open state, or from an open to a closed state.

[0010] The objectives have been accomplished by providing a flowable-material transfer system comprising conventional transfer apparatus for transferring flowable

material from a source container to a destination container, and a connector device according to the invention. The connector device comprises a source-container connector and a transfer-apparatus connector, whereby the source-container connector and transfer-apparatus connector mate to form a rugged, reliable, leak-tight connection. The connector device also includes several safety features that provide increased safety and reliability in the transfer of flowable material.

[0011] The conventional transfer-apparatus comprises a conduit system, a destination container, and optionally, a force system for applying a force to the flowable material as well as any number of valves and controls to effectively operate the force system. The force system may include, for example, a pressure pump to compel flow of the material through the system under the influence of negative or positive pressure.

[0012] It is generally understood that the direction of flow through the transfer system is in one direction. Thus, the inflow side and the outflow side of the components in the connector device do not change, that is, the inflow side is always the inflow side. The transfer-apparatus connector of the present invention has an inflow side that removably connects to the source-container connector, and an outflow side that connects to the transfer apparatus. A throughbore from the inflow side to the outflow side of the transfer-apparatus provides a flowpath through this connector. The source-container connector has a connector means on the inflow side that attaches to the source container, a flowpath formed by a throughbore from the inflow side to the outflow side, a flow valve placed in the flowpath, a valve-actuation assembly, a connector-device locking means, and a connector means on the outflow side that connects this connector to the inflow side of the transfer-apparatus connector. The inflow side of the source-container connector is directly attachable to the source container, or to a passage means connected to or extending from the source container. In many industrial situations, it is most efficient and convenient to permanently attach the source-container connector to the source container, as the apparatus used to transfer the material is

generally always the same or similar. The source-container connector, as provided for installation in a transfer system, is constructed to resist or prevent disassembly and to reduce the opportunity for failure.

[0013] Mating and securing of the transfer-apparatus connector to the source-container connector is best effected by a locking mechanism that is simple and easy to operate. In the connector device according to the invention, tabs are provided on the one or the other connector and interlock with flanged recesses on the corresponding other connector. Connection of the transfer-apparatus connector to the source-container connector way is accomplished with a single, quick, twisting motion of no greater than one-quarter turn. Once connected, the connector device according to the invention provides a flowpath from the source container to the destination container. Generally, the flow path is interrupted by a flow valve in the source-container connector.

[0014] For reasons of safety and effective control of the flowable material transfer process, a positive action is required to change the operative state of the flow valve. The flow-valve actuation assembly on the source-container connector comprises a flow-valve actuation means which holds the flow valve in its closed position or in its open position. It is noted here that it is important with regard to safety and effective control that the flow valve be neither opened nor closed inadvertently. Opening the valve inadvertently results in spillage or leakage of the flowable-material; closing the valve inadvertently may result in damage to the components of the transfer system. For this reason, a safety mechanism is provided on the valve-actuation assembly that keeps the valve from being easily unintentionally opened or closed. In one embodiment, the flow-valve actuation means is a spring-biased lever, although many other actuation means are known and suitable, such as a button that snaps into a detent, an electro-mechanical relay, or a hydraulic or pneumatic controlled mechanism. Only by applying a force against the spring is the lever movable from one operative position to another.

In a simple embodiment, this safety mechanism is a motion-limiting device such as a stop bar that limits or interrupts motion of the actuation lever.

[0015] The connector device according to the invention further comprises a disconnect-prevention means for blocking the disconnection of the transfer-apparatus connector from the source-container connector while the flow valve is open. The disconnect-prevention means is foolproof in that it is effective as soon as the transfer-apparatus connector is connected to the source-container connector and the flow-valve actuation means is moved to the open-valve position. The disconnect-prevention means remains effective and prevents disconnection of the transfer-apparatus connector from the source-container connector as long as the flow valve of the source-container connector is open. In a simple embodiment, the shape or contour of the transfer-apparatus connector provides an interference surface that effectively blocks disconnection. For example, one or more surfaces on the transfer-apparatus connector are in close proximity and aligned with the valve actuation means lever in its open-valve position such that the surfaces effectively block the one or the other connector from being rotated to the degree necessary to disconnect the connectors. Other suitable disconnect-prevention means are available, such as a pin or tab on one side and a hole or slot on the other, or electro-magnetic and pneumatic means.

[0016] Reducing sources of error of the connectors is a major concern with regard to the safety and reliability of the connector device and, for this reason, both the source-container connector and the transfer-apparatus connector according to the invention are manufactured substantially as single-piece, non-disassembleable components. Once the flow valve and valve-actuation assembly are assembled in the source-container connector, its housing is sealed to prevent one from replacing or repairing the internal components. Providing both the source-container connector and the transfer-apparatus connector as sealed units and made with a minumum number of parts reduces the

manufacturing costs and also contributes to the reliability of the device and, thus, of the flowable-material transfer system.

[0017] It is to be understood that other objects and advantages of the present invention will be made apparent by the following description of the drawings and detailed description of the preferred embodiment of the invention. While a preferred embodiment is disclosed, this is not intended to be limiting. Rather, the general principles set forth herein are considered to be merely illustrative of the scope of the present invention and it is to be further understood that numerous changes may be made without straying from the scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] **FIG. 1** is a perspective view of the connector device according to the invention.

[0019] **FIG. 2** is a side view of the transfer-apparatus connector.

[0020] **FIG. 3** is a front view of the transfer-apparatus connector of FIG. 2.

[0021] **FIG. 4** is a perspective view of the source-container connector.

[0022] **FIG. 5** is a perspective view of the mated connector device.

[0023] **FIG. 6** is an illustration of a disconnect-prevention mechanism.

[0024] **FIG. 7** is a schematic view of the flowable-material transfer system.

DETAILED DESCRIPTION OF THE INVENTION

[0025] **Figure 1** is a perspective view of a connector device **300** according to the invention. The connector device **300** comprises a transfer-apparatus connector **100** and a source-container connector **200** that mate to form a leak-tight seal and to provide a flowpath **F** for flowable material through the connector device **300**. In **FIG. 1**, the transfer-apparatus connector **100** is shown in close proximity to and ready to be mated to the source-container connector **200**. When the connector device **300** is installed for operation, the flowpath **F** through the connector device **300** is generally in the direction of an inflow F_I toward an outflow F_O, as indicated by the respective arrows. Hereinafter the arrows inflow F_I and outflow F_O shall be used to designate the inflow and outflow sides of all components of the connector device **300**.

[0026] **FIGS. 2** and **3** illustrate the transfer-apparatus connector **100** of the connector device **300** of the present invention. The transfer-apparatus connector **100** has an inflow side and an outflow side as indicated respectively by the arrows F_I and F_O. A first mating assembly **101** that includes flanges **102A** and **102B** and recesses **103A** and **103B** is provided on the inflow side. A throughbore **105** from the inflow side to the outflow side forms the flowpath **F** and terminates in an outflow opening **106**. In the embodiment shown, a connector extension **104** extends from the first mating assembly **101** for connecting the transfer-apparatus connector **100** with a mating surface on the source-container connector **200**. A compressible sealing ring **107** is fitted at the base of the connecting extension **104** to ensure a leak-tight seal of the connection. The outflow opening **106** includes a connecting means, not shown, to attach the transfer-apparatus connector **100** to apparatus of a transfer system, as discussed below. The connecting means is appropriate to the transfer apparatus and the type of flowable material being processed and may be a threaded, press-fit, clamped, pinned, or other appropriate means of connection.

[0027] **FIG. 4** illustrates the source-container connector **200** of the connector device **300** of the present invention. The source-container connector **200** comprises a housing **224**, a flow valve assembly **208**, a flow-valve actuation assembly **202**, a second mating assembly **210**, and a source-container attachment means **213**. The flowpath **F** through the source-container connection **200** is through the passage formed by the source-container attachment means **213** at the inflow side F_I and out an outflow opening **227** on the outflow side F_o, as indicated by the respective arrows. In the embodiment shown, the outflow opening **227** is constructed to receive the connector extension **104** and to provide a leak-tight seal in the flow path. The flow valve **208** is a conventional ball valve with a flowpath connecting passage **214** and is encased within the housing **201**. The flow-valve actuation assembly **202** comprises an actuation-assembly housing **217** with a sealed housing end **217A** (best seen in **FIG. 5**), a flow-valve actuation means **215**, a flow-valve actuation shaft **209**, and a valve-position-locking mechanism **203.** The flow-valve actuation shaft **209** is fixedly attached to the flow valve **208** and is enclosed in the flow-valve actuation assembly housing **217**. The actuation means **215** is fixedly attached to the flow-valve actuation shaft **209** and extends out through an actuation slot **216** in the flow-valve actuation assembly housing **217**. The flow-valve actuation shaft **209** has a longitudinal axis that runs perpendicular to an axis that extends longitudinally through the center of the flow-valve throughbore. The actuation means **215** is keyed to the flow-valve actuation shaft **209** such that rotating the actuation means **215** radially about the longitudinal axis of the flow-valve actuation shaft **209** forces the flow-valve actuation shaft **209** to rotate correspondingly, which causes the flow valve **208** to open or to close.

[0028] The valve-position-locking mechanism **203** comprises a stop bar **218** and a biasing spring **219**. The flow-valve actuation slot **216** has a first edge **216A** that is closer to the flow valve **208** and a second edge **216B** that is closer to the sealed housing end **217A**. The biasing spring **219** is assembled on the flow-valve actuation shaft **209** and normally biases the actuation means **215** up against the first edge **216A**.

The stop bar **218** juts from the flow-valve actuation assembly housing **217** from the first edge **216A** into the actuation slot **216** and extends far enough into the actuation slot **216** to prevent the actuation means **215** from being moved the entire length of the actuation slot **216** while it is still biased up against the first edge **216A**. In effect, the stop bar **218** delineates a valve-open position **205** (seen in FIG. 5) and a valve-closed position **206**. The actuation slot **216** is wide enough and the stop bar **218** short enough to allow the actuation means **215** to be rotated past the stop bar **218** when the actuation means **215** is pulled against the biasing force toward the second edge **216B** of the actuation slot **216**. Thus, the actuation means **215** must first be forced to the second edge **216B** of the actuation slot **216** before it is rotatable along the actuation slot **216** from the valve-closed position shown in **FIG. 4** to the valve-open position shown in **FIG. 5** and, similarly, before it is rotatable in the opposite direction.

[0029] It is understood that the valve-position-locking means **203** of the embodiment of the present invention is one of many possible means of actuating and securing the operative state of the flow valve **208**. For example, any manual means, such as a knob or push button that snaps into an opening, may be used, depending on the type of valve employed, and any electrical, electronic, pneumatic, or other actuation means appropriate to the particular use of the connecting device. Regardless of the means of actuation, the source-container connector according to the invention incorporates a valve-position-locking means for preventing inadvertent and careless operation of the flow valve. Many stopping means exist, other than the stop bar **218** of the preferred embodiment of the present invention, to impede or prevent inadvertent and accidental valve actuation, such as a detent, a safety latch, a keyed lock, an electrically or otherwise remotely operated safety switch, lever, pin, or catch, or other means according to the particular use and environment of the connecting device in the flowable-material transfer system.

[0030] With respect to all possible embodiments of the present invention, it is understood, but not shown in the drawings, that a sealing means is provided around the flow valve **208**, or any substitute valve, and around the flow-valve actuation assembly **202**, or other actuation means that resides in or is connected into the flowpath. Such a sealing means prevents leaking of the flowable material around these parts. Further, this sealing means may also serve as, and be identical to, a bearing surface on which the parts move.

[0031] Now referring to **FIGS. 1** and **4**, the second mating assembly **210** at the outflow side F_O of the source-container connector **200** is shown having a planar surface and tabs **223A** and **223B** that extend outward from the housing **201** in the same plane as that of the planar surface. The ends of the tabs **223A** and **223B** are radiused. Note that the actuation means **215** as shown in **FIGS. 1** and **4** is shown in the valve-closed position **206**. The source-container connector **200** is, thus, in its valve-closed position when it is not connected to the transfer-apparatus connector **300**. As shown in **FIG. 1**, the transfer-apparatus connector **100** is positioned with respect to the source-container connector **200** such that the first mating assembly **101** faces the second mating assembly **210** in a substantially parallel alignment, with the connector extension **104** in the first mating assembly **101** aligned with the outflow opening **227** in the second mating assembly **210**. Having thus positioned the transfer-apparatus connector **100** and the source-container connector **200**, the first mating assembly **101** and the second mating assembly **210** are brought together. The second mating assembly **210** fits between the flanges **102A** and **102B** of the first mating assembly **101**, allowing the connector connecting extension **104** and the sealing ring **107** to be seated inside the outflow opening **227** of the source-container connector **200**. The transfer-apparatus connector **100** is then compressed against the source-container connector **200** and rotated one-quarter turn, so that the recesses **103A** and **103B** of the transfer-apparatus connector **100** engage and capture the tabs **223A** and **223B** of the source-container connector **200**. This mating action compresses the sealing ring **107** of the transfer-apparatus

connector **100** and positively attaches the transfer-apparatus connector **100** to the source-container connector **200**.

[0032] **FIG. 5** now shows the source-container connector **200** and the transfer-apparatus connector **100** mated together as the connector device **300**. After the transfer-apparatus connector **100** and the source-container connector **200** are securely mated, the actuation means **215** may be lifted away from the first edge **216A** of the actuation slot **216** and rotated along the actuation slot **216** past the stop bar **218** to the valve-open position **205**, as depicted in **FIG. 5**. The ball valve **208** is open in this configuration and the flowpath **F** extends from the inflow side $\mathbf{F_I}$ of the source-container connector **200** to the outflow side $\mathbf{F_O}$ of the transfer-apparatus connector **100**. The flowpath **F** is unimpeded and flowable material is transferable through the mated connector device **300**.

[0033] **FIG. 6** illustrates a second safety feature on the connector device **300** according to the invention. This second safety feature, a disconnect-prevention means **212**, prevents the transfer-apparatus connector **100** from being disconnected from the source-container connector **200** while the flow valve **208** is open. The illustration in **FIG. 6** is a planar view of the connector device **300** from the outflow $\mathbf{F_O}$ side of the transfer-apparatus connector **100**, showing the actuation means **215** in the valve-open position **205** and the transfer-apparatus connector **100** rotated approximately 1/8 of a turn. The disconnect-prevention means **212** is an interference configuration of the actuation means **215** and a surface of the transfer-apparatus connector **100**. As indicated by the asterisk, the actuation means **215** in it valve-open position hits up against the transfer-apparatus connector **100**, preventing it from being rotated the full ¼ turn, which is needed to release the second mating assembly **210** from the first mating assembly **101**. In the embodiment shown, the transfer-apparatus connector **100** is fabricated as a rectangular block, and the actual point of interference between the actuation means **215** and the transfer-apparatus connector **100** is the edge of the block

that is on the inflow side of the block. It is not necessary that the transfer-apparatus connector **100** be formed as a rectangular block. In order for the disconnect-prevention mechanism to function, however, it is critical that the actuation means **215**, when in its valve-open position **205**, be situated close to the transfer-apparatus connector **100** and/or the transfer-apparatus connector **100** provide a contour such that interference between the actuation means **215** and the transfer-apparatus connector **100** occurs when the connector **100** is rotated less than ¼ of a turn to the right or to the left of the actuation mechanism **203**.

[0034] The connector device **300** may be constructed of any materials that are suitable for its intended application. In many applications in which the connector device **300** is subjected to positive or negative pressures,and/or to caustic or corrosive materials, it may be desirable to construct the device with particularly rugged materials, such as cast metal, metal alloy, composites, cermetal materials, or any combination thereof. In other applications, lighter loads may allow some components to be constructed of synthetic or composite materials. Similarly, the connectors between the source-container and the source-container connector **200**, and the transfer-apparatus connector **100** and transfer apparatus may be any means suitable to the type of flowable material being transferred and to the environmental requirements. Accordingly, it is within the scope of the invention to include such connector means as threaded, press-fit, clamped, pinned, adhered or other suitable conventional connector means. As well, the source-container connector **200** and/or the transfer-apparatus connector **100** may be permanently attached to, or constructed as an integral part of, the source container and the transfer apparatus, respectively.

[0035] Although the preferred embodiment of the present invention detailed herein uses tabs and corresponding flanges that require a quarter turn to connect the connectors, alternative embodiments may use any number of tabs and corresponding flanges, and such configurations may require a twist through a smaller arc to effect the

attachment. Also, a stop or block may be added to one or more of the tabs or flanges to prevent over-twisting in other embodiments of the present invention. Furthermore, a particular alternative embodiment of the present invention may incorporate compressible or solid bosses into the tabs and/or the flanges, on the surface of one or both, in order to produce a more positive fit and connection of the mated openings and mating assemblys and/or greater compresson of the seal.

[0036] It is also to be understood that, just as various types of valves, valve actuation means, and actuation impeding means may be employed in the source-container connector of the present invention, so too may various disconnect-preventon means be employed according to the particular type of valve and/or actuation means used. For example, such means may be mechanical, such as a tab and slot, a pin and hole, post and stop, or magnetic, electrical, electronic, pneumatic, or other suitable types of control means.

[0037] **FIG. 7** is a schematic illustration of a flowable-material transfer system **900** of the present invention. Fundamentally, the connector device **300** of the present invention resides between a source container **500** holding flowable material and a destination container **700** to which the flowable material is to be transferred. The arrows **P** in **FIG. 6** represent connecting passages between the various components of the flowable-material transfer system **900**. The direction of the arrows indicate the direction of flow of the flowable material and/or the direction of pressure exerted on or in the flowable-material transfer system **900**. The broken line between the source-container connector **200** and the transfer-apparatus connector **100** represents the connectable/disconnectable connector device **300,** although, depending on the use to which the flowable-material transfer system **900** is put, any number of points of disconnection and disassembly may be present. Nevertheless, the mated connecting device **300** is a critical component of the flowable-material transfer system **900** and, in a

particular embodiment, may be the only such point of disconnection between the source and destination containers **500/700**.

[0038] Although the flow valve **208** of the source-container connector **200** is the only valve shown in this schematic of the flowable-material transfer system **900**, it shall be understood that other valves and flow-control devices may be present at various points in the system to assist the flow of the material or to prevent back-flow of the material being transferred. Furthermore, any number of automatic or manual shut-off valves may be placed at locations where dissassembly or failure of the system may be expected. The source-container connector **200** is affixed to the source container **500** either directly or by a passage means of pipe, hose, tubing, duct, bored block, or other conduit. Similarly, the transfer-apparatus connector **100** is affixed to the destination container either directly or by such passage means.

[0039] A configuration of the flowable-material transfer system **900** comprising only a source container **500**, a source-container connector **200**, a transfer-apparatus connector **100**, a destination container **700**, and the passage means between them is one that relies on natural forces, such as gravity, or inherent conditions, such as pressure differential, to effect the movement of the flowable material. An alternative configuration of the flowable-material transfer system **900** employs a pressurizing means **400** to exert positive pressure on the flowable material in the source container **500** to expel it from the source container **500** through the mated connecting device **300** and into the destination container **700**. The pressure applied may result from mechanical (e.g., a piston or plunger), hydraulic, fluidic, thermodynamic, or any other forces suitable to move the particular flowable material and appropriate for the components from, through, and to which the material is moved.

[0040] Another alternative embodiment of the flowable-material transfer system **900** employs a pumping means **600** to exert negative pressure on the flowable material, thereby drawing it from the source container **500**, and positive pressure in the direction

of the destination container **700**, thereby forcing the flowable material into the destination container **700**. Any suitable pump or pump-like device, including, for example, a convection or capillary-action inducing device, may be employed, according to the nature of the flowable material and the components from, through, and to which it is moved. The pumping means **600** may be located either between the source container **500** and the source-container connector **200**, or between the transfer-apparatus connector **100** and the destination container **700**, or both.

[0041] Yet another alternative embodiment of the flowable-material transfer system **900** employs a depressurizing means **800** to exert negative pressure on the destination container, thereby drawing flowable material from the source container **500**, through the mated connecting device **300**, and into the destination container **700**. Depressurization of the destination container **700** may result from mechanical, hydraulic, fluidic, thermodynamic, or any other force produced or introduced by the depressurizing means **800**. Any combination of a pressurizing means **400**, pumping means **600**, and/or depressurizing means **800** may be employed within any of the various possible embodiments of the flowable-material transfer system **900**.

[0042] It is understood that the embodiment described herein is merely illustrative of the present invention. Variations in the construction of the connecting device and the flowable-material transfer system of the present invention may be contemplated by one skilled in the art without limiting the intended scope of the invention herein disclosed and as defined by the following claims.